The rationale of surgical treatment in pediatric spine tuberculosis

by Komang Agung Irianto

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Komang Agung Irianto*

ABSTRACT

Introduction: Extrapulmonary TB in pediatric patient affects the quality of life and must be considered seriously. Early surgical treatment is needed to eradicate infection, preserve the physis, and simultaneously correct the deformity. The aim of this study is to assess the efficacy of conservative treatment compared to early surgical treatment regarding neurological improvement, kyphotic correction, and pain relieve.

Method: This is a retrospective case series. We reviewed 28 pediatric spine tuberculosis in Dr. Soetomo General Hospital Surabaya, Indonesia during year 2010-2012. All patients have received TB drugs and indicated for surgical treatment, yet the 15 patients did not provide parental consent. These were selected as non-surgical group. Thirteen patients obtained surgical treatment including bone graft, w/o instrumentation (surgical group). All clinical data were collected at the time of diagnosis and a year after treatment. The improvement of kyphotic (thoracic segments) was defined as narrowing of post-treatment Cobb's angle. Conversely, lordotic improvement (cervical or lumbar segments) was defined as widening Cobb's angle. Improvement of neurological status (Frankel classification) was analyzed using chi-square test. The deformity correction and pain relieved were analyzed using independent-samples t-test. All statistical analyses were conducted by SPSS-23.

Result: VAS improvement was not significant. Frankle classification in the surgical group was significantly better. The kyphotic deformity correction was 0% (n=8) in the non-surgical group and, 57.1% (n=4) in the surgical group. The lordotic deformity correction was 74.1% (n=4) in non-surgical group and 83.3% (n=5) in surgical group. There is a significant difference of the kyphotic deformity correction between both groups. but no significant difference in lordotic correction.

Conclusion: Surgical management showed better outcomes in the degree of correction (stopped and corrected the kyphosis progression), and also in the neurological improvement.

Keywords: pediatric spine, extrapulmonary tuberculosis, spinal deformity
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*Orthopedic and Traumatology Department, Dr. Soetomo Hospital Surabaya
Medical Faculty Airlangga University Surabaya

INTRODUCTION

Pediatric spine patients should be managed comprehensively since spine deformity has not only short-term impacts but also affects long-term morbidity.[1,2,3,4] Every decision should be taken into account for the possibility of disturbing the growing spine, either increasing the destruction or elevating the kyphosis deformity.[5,6] Indonesia is one of 22 High Burden Countries (HBC) responsible for 85% of TB cases for global burden according to WHO (2015) and one of six countries where 60% of TB cases were from.[7] The issue of MDR (multiple drug resistant) in TB/HIV is also critical, especially if the chemotherapy could not eradicate the infection directly in the first place. Recurrent cases have to be prevented.[7]

Infection of Mycobacterium Tuberculosis is notorious for the local destructive effect by activated macrophages to get rid of the agent yet ended up necrotizing the host tissue forming the so-called cold abscess. The necrotic tissue complicating the effectiveness of the antimicrobial agent seldom fails to stop the progress of the osteo-joint destruction.[4,5] This is one of the reasons for aggressive management for pediatric spine tuberculosis, such as by early surgical decision either by doing debridement only or incorporating instrumentation.[3-5,8-10]

The MRC TB working group reported that the surgical intervention group had a better 15 years follow up result than the conservative chemotherapy group. Early surgical treatment is needed to eradicate infection, preserve the physis, and simultaneously correct the deformity.[8,9,10] Spinal surgery is still one of the most frightening options for parents in Indonesia; some patients were treated without surgery and only with TB drug and external mobilization (brace or cast). Some major TB protocols for extra pulmonary TB still propose conservative treatment with prolonged TB multidrug use to 12-16 months.[6,8-12] This would bring another barrier to successful DOT for the drug toxicity or the compliance to finish the full course of treatment.

The purpose of this study is to assess the efficacy of conservative treatment compared to surgical procedure regarding pain relieved (VAS), neurological improvement (Frankel classification), and kyphotic correction.

*Correspondence to: Department of Orthopedic and Traumatology, Dr. Soetomo General Hospital, Jln. Prof Dr Moestopo 8-10, Surabaya, Indonesia
komang168@yahoo.com

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METHOD

This retrospective study of 28 pediatric spine tuberculosis cases in the Orthopedic Department, Dr. Soetomo General Hospital Surabaya, Indonesia has been approved by the Institutional Review Board. It comprised of 15 conservative management and 13 surgical management during 2010-2012. All patients were active new tuberculosis cases, excluding the *no healed patients*. Surgical indications are including wide cold abscess, neurological deficit, number of level of involvement, and progressive kyphotic deformity. Rendering to the surgical indication criteria, all 28 patients were eligible for surgery, yet 15 patients were treated non-surgically due to their parent's decision not to perform surgery at all cost.

All patients were treated with TB multidrug for 12 months according to TB National Guideline protocol for extra pulmonary TB. External immobilization was applied as soon as possible for three months and then replaced with brace until patients are mature (14-16 years old). The surgical procedure includes debridement, bone graft from costa bone, and instrumentation with the pedicle screw. The surgical approach was either anterior or posterior, based on the location of the dominant abscess lesion and the severity of the deformity. Pedicle screw was applied depending on the site and level of involvement. For cervico-thoracal (C7-T1) or lumbosacral (l5-S1), we conducted posterior approach.

Clinical data were collected (VAS, Cobb Angle, Frankle classification) and patients were reexamined after they completed the 12-month course of multidrug. Laboratory examination and radiological follow up were conducted to observe the effectiveness of the treatment. Data of pain score (VAS), neurological deficit by Frankel Classification, and the initial Cobb's angle and one-year post-treatment were compared between the non-surgical and surgical groups.

The analysis of Cobb's angle improvement or worsening was further divided into two groups, one of kyphotic deformity (involving thoracic vertebral segments) and one of lordotic deformity (involving cervical or lumbar vertebral segments). Improvement of kyphotic deformity was defined as narrowing of post-treatment Cobb's angle, and the worsening of the deformity was defined as widening. Conversely, improvement of lordotic deformity was defined as widening of post-treatment Cobb's angle and the worsening was defined as narrowing. Improvement was assigned as a positive value in the analysis and vice versa.

VAS and Cobb's angle were compared by using independent-samples t-test. Improvement of neurological status by Frankle classification was analyzed using chi-square test. All statistical analysis was conducted using SPSS version 23.

RESULTS

The non-surgical group including 15 children (10 males and five females) in the range of 3-18 years old. The surgical group comprised of 13 children (6 males and 7 females) between 3-17 years old. The demographic data (Table 1) showed similar age, level of lesion, and number of segments. But unfortunately, the neurological deficits in the

Table 1 With shades for the left part (non-surgical group) and without shades for the right part (surgical group)

Case	Sex	Age	Level	Number of Segments	Case	Sex	Age	Level	Number of Segments
1	M	18	L3-L5	3	1	M	3	L2 - S2	6
2	F	12	L4-S1	3	2	M	7	C3 - C4	2
3	M	7	C7-T3	4	3	F	9	C7 - T2	4
4	M	3	C6-T4	6	4	M	7	T8 - T9	2
5	M	3	T8-T9	2	5	M	17	T7 - T12	6
6	M	3	T12-L2	3	6	F	15	T8 - T11	4
7	F	5	T4-T5	2	7	F	4	T4 - T6	3
8	M	6	T11-L2	4	8	F	7	T12 - L1	2
9	F	6	L2-L5	4	9	F	7	T9 - L1	5
10	F	10	L1-L4	4	10	M	4	L1 - L2	2
11	M	14	T8-T9	2	11	F	12	L5 - S2	3
12	F	6	T8-T11	4	12	M	10	L2 - L5	4
13	M	7	L3-L5	3	13	F	12	L4 - S1	3
14	M	17	L2-L3	2					
15	M	17	L3	1					

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Table 2 VAS, Frankel, & Kyphotic/Lordotic in surgical and non-surgical group

	Surgical (n=13)	Non-surgical (n=15)	P-values*	P- values†
VAS initial	6.61 ± 1.86	6.13 ± 1.746		0.52
VAS 1-year post-treatment	2.07 ± 1.206	2.4 ± 1.306		
FS improved	8	2	0.008	
FS not improved	5	13		
Kyphotic improvement	-12.14 ± 23.91	10.875 ± 5.50		0.034*
Lordotic improvement	6.83 ± 5.81	2.57 ± 7.08		0.304

VAS=Visual Analogue Scale; FS= Frankel Score; Ky= Kyphotic deformation; L=lordotic deformation
Numerical data was presented in (Mean+SD),
p-value*: data was tested by chi-square test
p-value†: data was tested by independent t-test

Figure 1 3-year-old boy suffering from malnutrition showing gibbus around vertebrae thoracal VIII-IX without neurological deficit. Patient was treated conservatively with TB multidrug. X-ray showed progressive kyphosis angle after two months treatment from 22°(b) to 30°(c)

Figure 2 7-year-old girl with spondylitis TB in vertebrae thoracal XII-Lumbal
A. Pre-operation gibbus and 46° kyphotic angle
B. Six months post-operation, without gibbus, corrected kyphotic, and not malnourished anymore

non-surgical group was not as severe as in the surgical group on the first assessment before the treatment.

The pain score (VAS) decreased from 6.13 to 2.4 in the non-surgical group and from 6.61 to 2.07 in the surgical group (Table 2). No significant difference was found between VAS in the non-surgical and surgical group (p=0.52).

The Frankel classification in the non-surgical group was improved in only two cases (13.3%), D to E, and C to D. In the surgical group, Frankel status was improved in eight cases (65.1%) and was not improved (Frankle D and E) in five cases. In regard to neurological deficit, we found significant result (p=0.008).

Among eight patients with kyphotic deformity of the non-surgical group, none of the patients showed improvement. Meanwhile, 57.1% (n=7) of the patients treated surgically showed improvement. There is a significant correction of kyphotic deformity between the non-surgical and surgical patients (p=0.034).

There is 74.1% (n=7) lordotic deformity in non-surgical group and 83.3% (n=6) in the surgical group who showed improvement. However, there is no significant difference of correction achieved between both groups (p=0.304).

DISCUSSION

The rule of thumb for treating any infection is to eradicate the infection itself, especially in spinal tuberculosis where it tends to form wide necrotic tissue and destroys the bone, joint, and surrounding soft tissue, the eradication needs specific strategies and bold management decision. Pediatric spine tuberculosis is a packet of problem to be solved due to the nature of tuberculosis, the nature of the growing spine, as well as the nature of balanced nutritional intake (most patients were malnourished) and immunocompromised condition.[5,8,9,12,13] Surgeries are controversial due to the perception of

the risks of surgical techniques in such small and young patients. Not to mention, there are many successful reports of anti-TB chemotherapy for treating spondylitis Tuberculosis conservatively without surgical intervention.[6] In many centers around the world, surgery is still considered controversial and must be decided carefully and individually based on strict criteria. The ultimate goal of the treatment is a complete recovery from the infection.[2-5,7-10]

Pain relieves

Pain in children is not easy to assess. VAS must be evaluated carefully. For children younger than seven years old, visual score is more applicable. Pain in spine tuberculosis is caused by instability of the spine and the compression effect of dead material such as an abscess or bone destruction.[4,5,6] The VAS in the non-surgical group were decreased from 6.13 to 2.4 while in the surgical group the VAS was reduced from 6.61 to 2.07. The pain relief was significant but there was no significant difference between both groups. The VAS is very seldom discussed for pediatric spine patients, but we include it as part of the quality of life. The pain would subside faster in the acute time post-surgery. Since the evaluation is conducted after one year, the pathology process will have been subsided, both conservative and surgical treatment would achieve the same modality.

The surgical debridement procedure removing dead necrotic material would decompress and stabilize the spine at once, promptly relieving the pressure and the compressed inflammation effect. After medical treatment, eventually, the pain will also be relieved. The pain relieves also indicates the infection has been significantly cured.

Neurological deficit

The neurological deficit mostly improved after surgical treatment. Unfortunately, the sample was not well distributed; the non-surgical group was not as severe as the surgical group initially before the treatment. These were also one of the reasons why parents were worried that the non-paralyzed patient could have worsened neurological deficit post-surgery. Neurology deficit in spine tuberculosis is caused by compression of dead material or bone destruction that encroached the canal.[12,13,14] By doing an early surgical evacuation, decompressed earlier and prevented irreversible pathologic extension to myelum (myelitis). The bad hemodynamic in the necrotic lesion could induce thrombosis of spinal cord vascular, which would affect the spinal cord function.

The early decompression management successfully decreased the deficit in eight out of 13 surgical group patients while five patients with minimal deficit classification (Frankle E & D) were not worsened. On the contrary, only two patients out of 15 non-surgical group decreased the deficit; one patient from C to D and one patient from D to E. While 13 patients were not better nor worse, seven out of the 13 patients were bearing minimal neurological deficit (Frankle E).

Kyphotic correction

Only after the early 2000s, major centers around the world started to pay attention to the quality of the patient's life when they have to bear the kyphotic deformity which itself would be comorbid for future back pain, not to mention the cosmetic implication.[2,5,14,15] A series of clinical trials were held and organized by the British Medical Research Council (BMRC) since 1970. The trials include three branches, in South Korea, South Africa, and Hong Kong. In Korea, 350 patients of spinal TB were enrolled for the medical management, and in Hong Kong, 150 patients all underwent surgery. The 15-years follow up showed similar healing results. The clinical trial did not mention the kyphotic deformity correction.[8,9] Medical Research Council (MRC) working party on spinal tuberculosis (2013) concluded that the surgical group had the best results because these patients had more rapid abscess resolution, as well as earlier and more frequent bone fusion.[8,9,10]

The strategy applied in dealing with pediatric spine tuberculosis is to stop the progression of the deformity and preserve the alignment. While preventing neurology deterioration and pain relief are crucial, in the end, the primary goal is to eradicate infection totally. The re-infection or relapse case is to be avoided, especially in Indonesia.[7] Most of our spinal tuberculosis patients were purely extrapulmonary, which means they did not have the standard diagnosis of sputum and thorax X-ray as well as the tools to evaluate the treatment's outcome. We learned that by doing a surgical intervention, we also allow exact early diagnosis for dubious cases and comprehensive treatment. The anti-Tuberculosis drug works more effectively and efficiently since the dead materials of caseous necrotic tissue were removed, allowing revascularization to the lesion. Those are the same recommendations from American Thoracic Society, CDC, and Infectious Diseases Society of America.[16]

Akiyoshi Hoshino et al. reported on how Mycobacterium tuberculosis-infected multinucleated osteoclast lost the ability as

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proinflammatory (2014).[17] The infected resident multinucleated osteoclast is reprogrammed to produce specific chemokine-induced osteolytic process, which worsened the necrotizing tissue, while the Tuberculosis less influences the precursor new osteoclast. That is another reason why removing the necrotic tissue is essential. By bringing new fresh tissue, revascularization, new precursor osteoclast and osteoblast, together with the anti-tuberculosis chemotherapy, would allow ascertaining prevention for recurrent infection.

In the surgical group, the surgical approach is decided according to the level of the abscess and the destructive segment to maximize the evacuation of the pus, decompress the area, and stabilize the destructive bone joint.[19-26] While the radical debridement is underway, it is best to preserve the remnant growth plate.[15-18,27,28] The fresh and healthy tissue after evacuating the dead material and the effective anti-tuberculosis treatment would also allow the bone and joint to repair and reform faster. Those healing processes also relief pain faster and reprieve neurologic deficit, which allows optimal growth and alignment for the child. This way, the surgery could be undertaken safely without interrupting major vital organs in the vicinity of the aorta, lung, and spinal cord itself.[18]

In our study, the neurological deficit improvement and kyphosis correctional were better in surgical intervention. The debridement and instrumentation did not lead to further infection, nor decreased outcome. A study by Hsuan KK. et al. (2010)[28] reported that radical debridement in the physis area, as long as it did not destroy the growth plate itself, would not disturb the growing bone. In growing spine, the growth plate is hard to evaluate during surgery; we prefer preserving the disc by evacuating the necrotic tissue as much as possible and stabilizing the disc by elevating the spaces through inducing bone graft and incorporating the pedicle screw.

This study implies the importance of surgical management for pediatric spine TB. More attention needs to be paid to spinal TB in Indonesia, especially in children whose lifetime quality of life is at stake. We encourage multicenter study and longer period to come out with more ensuring data.

CONCLUSION

Surgical management showed better outcomes in the degree of correction (stopped and corrected the kyphosis progression) and also in the neurological improvement. The pain score (VAS) was not significant because the evaluation was conducted one year after diagnosis.

CONFLICTS OF INTEREST

All authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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